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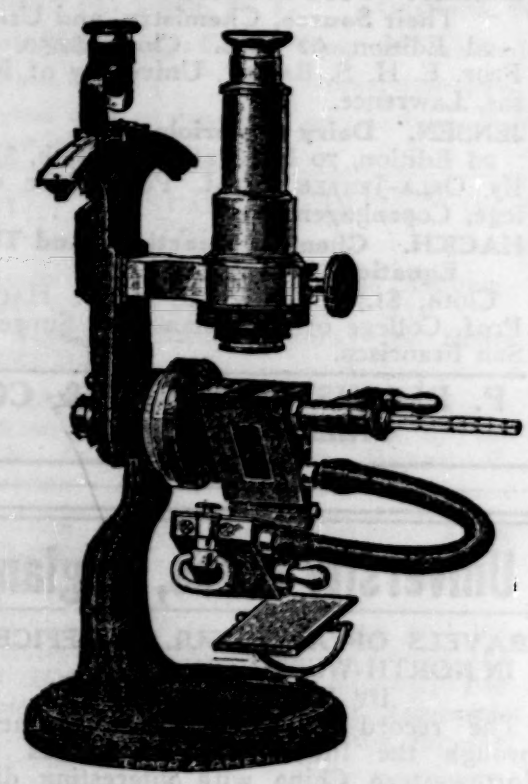

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THE TREND OF EARTH HISTORY[1]

SOME years ago a witty member of the mining engineering profession read a paper before the Canadian Institute of Mining Engineers, picturing geologists, and particularly historical geologists, as a group of romancers—the lineal descendants and heirs of the old professional story-tellers of the middle ages. He accounted for the general popularity of the subject of geology by the fact that every one loves a story-teller, while but few people are interested in questions of cold fact.

Nearly all opinions, correct or otherwise, are based upon a modicum of fact; and so, for this impression of historical geologists as dreamers and story-tellers, there is a certain foundation in reality. It will scarcely do, however, to accept so distorted a picture as even an approximation to the truth.

Are the data with which the student of Earth history works so obscure, so fragmentary and so equivocal that his conclusions are not entitled to confidence? In part, Yes; but in large measure, No. They are in fact much like the data of human history, and particularly of archeology. That they are not exact quantitative evidence is true, and this tends to make them seem untrustworthy in the eyes of the student of the more exact sciences. Nevertheless, the data are real, and safe conclusions may be drawn from them if care and due caution are applied to the operation. Furthermore, the solving of one problem often leads to the solution of another which had previously resisted all attempts at interpretation. In spite of the obvious incompleteness of the geologic record, we nevertheless have a large number of clearly ascertained facts about the physical and biologic history of the earth, and

[1] Address of the Vice-President and Chairman of Section E—Geology and Geography, American Association for the Advancement of Science, Toronto, December 28, 1921.

even some hints about its birth and antecedents.

The biologic phase of the subject overshadowed the physical in the minds of the historical geologists of the nineteenth century so largely that we now know more about the character and sequence of organic forms than about other phases of the Earth's history. Courses in historical geology have generally been taught by paleontologists, and the history of animals and plants fills most of the pages devoted to historical geology in textbooks and manuals. In the last few decades, however, more and more attention has been given to the nature and sequence of the climates, physiographic changes, volcanic outbursts and other physical events; and our knowledge of this phase is now growing so rapidly that it bids fair to overhaul and pass the earlier wave of biological study. To appreciate the truth of this statement, it is only necessary to scan the list of papers that have been published in recent years on such subject as unconformities, sedimentation, orogenic epochs, paleogeography, physiographic history, glacial epochs, and the like.

The study of the physical history of the Earth assumes new aspects from decade to decade, as a question here and there is answered and other problems arise out of the interaction of newer ideas. One of the commonest questions which geologists are asked is —"How old is the earth?" and "How many years have elapsed" since this or that event in its history took place? The question has been attacked from many angles, and although exact calculations are not yet and perhaps never will be possible, we may have increasing confidence in the general character of the returns.

Counting the growth-rings in the big trees of California shows that some of those giant growths are more than 4,000 years old, and yet no marked change has taken place in the surface of the land on which they stand since they sprouted from the soil.

Baron De Geer, after a most painstaking study of the laminated glacial clays of northwestern Europe, seems to have compiled a definite record of seasonal changes of deposition covering some six or seven thousand years, during which certain post-glacial lakes were being filled with deposits of silt.

Less accurate estimates of geologic time have been based on recessions of Niagara Falls and other cataracts. These problems are usually complex and the factors not all well known. Hence, estimates of the number of years since the ice sheet left Niagara vary all the way from 7,000 to 50,000 years. Nevertheless, this gives a general order of magnitude which is of value. The mean of the two extremes is probably not very far from the truth.

The most complete part of our geologic record is the composite pile of strata of the sedimentary rocks. Many attempts have been made to translate the thickness of these beds into terms of years, but our knowledge of the rate at which sediments accumulate under various conditions is still far too inaccurate. We know rates in certain isolated instances, but they vary within wide limits, and we do not yet understand the factors that govern the variations. There is good reason to believe, however, that the rate of deposition generally has been overestimated, and hence the periods of time have been made too short.

Within the last fifty years, the various estimates which have been made of the time represented by the Paleozoic, Mesozoic and Cenozoic eras have varied between three million years for the lowest and six thousand million years for the highest. The average of twenty such estimates is about 250 million years, but most of the individual figures are about 100 million or less.

On the whole, from decade to decade there has been a disposition to lengthen the estimates, as the testimony of the stratigraphic column became better understood. In 1893, Walcott allowed 45 to 70 million years for the three eras. In 1899 Geikie estimated 100 million years. In 1913, Holmes calculated an average of about 300 million years for the same group of periods, and, in 1916, Barrell suggested 360 to 540 million years as the best estimate based on the sedimentary deposits. This tendency to recognize more clearly the immense duration of the various geologic periods has been due largely to a growing un-

derstanding of the many diatems, or interruptions in the stratigraphic column, as well as variation in the rate at which different types of sediments have been laid down.

Soon after the discovery of the fact that radium undergoes an exceedingly slow decomposition leaving helium and lead as products, it was found that the minerals of the oldest rocks contained more helium and lead than those of younger rocks. The following are a few examples selected from the calculations by Strutt expressed in terms of the time from certain periods down to the present:

1. Miocene ..... 6 million years
2. Upper Carboniferous.....146 million years
3. Early pre-Cambrian.....710 million years

Holmes recognized that much of the gas emitted might have escaped during the subsequent existence of the minerals. Using the less migratory element, lead, as a basis of calculation, he reached the figures 1,000-1,600 millions years for the age of certain minerals from the Archean rocks. It is particularly significant, that the testimony of different minerals from the same intrusion, considering the errors expectable in analytic work, generally agrees rather closely; and there is almost as good a correspondence between the lead ratios of minerals of the same general age but from widely separated localities. According to Barrell's interpretation, the rare-earth minerals of the Llano uplift in central Texas contain uranium-lead indicating an age of about 1,125 million years. They are roughly of middle pre-Cambrian Age. Unless there are concealed sources of error in the careful work of our best radiologists, we seem justified in accepting their estimates as fairly satisfactory approximations—very much the best we have ever had—which indicate that the Mesozoic rocks are tens of millions, the Paleozoic rocks hundreds of millions, and the most ancient pre-Cambrian rocks more than 1,500 millions of years old.

Reviewing these attempts to express the history of the earth in terms of years, we find that from the time of Archbishop Ussher and his estimate of 5,700 years for the total history of the earth up to his day, or even Lord Kelvin who allowed 20 to 40 million years for the entire evolution of the planet, the tendency has been to greatly increase our estimates of the length of time involved in even the later part of the Earth's history; for we must not forget that the time from the earliest Archean period to the present is probably very short, as compared with the time that has elapsed in the formation of the earth as a planet and is to elapse before its final refrigeration—if such is ever to occur. The contemplation of such vast lapses of time makes the brief span of human history seem absurdly short. It is difficult to realize, when studying "history," commonly so-called, that we are reading only the latest chapter of the last volume of a great series of tomes numerous enough to fill a large library.

The physical events that crowded this tremendous space of years are being made known as geologic field studies progress. Among them are the orogenic disturbances, or diastrophic revolutions, when long winding wrinkles were bulged upon the Earth's surface, only to waste away under the slow attack of the weather. While they are in this process of decay, we call them mountain systems. At such times, the shallow epicontinental seas are generally withdrawn into the ocean basins, the average height of the continental masses above sea-level is increased, and the work of erosion accelerated.

That part of North America now occupied by the Rocky Mountain System was, from before the Cambrian down to the Cretaceous period, for the most part a region of plains or low hills, undergoing either general erosion or decomposition. Much of the time it was sea-bottom. Then followed a period of profound disturbance. The stratified rocks were wrinkled into folds, and their foundation of ancient crystalline rocks compressed and mashed beneath them. Great slices were sheared over the subjacent mass for many miles. Molten lava welled up into the disturbed formations and even burst forth on the surface scattering cinders and volcanic dust far and wide. Remnants of the lava flows and stocks still mark the sites of volcanic cones which have since been demolished. This disturbance subsided, but was repeated soon afterward at the close

of the Paleocene Period. The deformation was again renewed in the Miocene period and in a milder form still more recently. From the bulged and wrinkled tract thus prepared, the Rocky Mountains, as we know them to-day, have been carved by the combined agencies of erosion.

By contrast, on the eastern slope of North America, periods of relative stability in the crust alternated with these compressive disturbances, from a remote pre-Cambrian time down to about the close of the Paleozoic era. Since then the region has been comparatively quiet, and its history is chiefly the story of the erosion of the surface, modified from time to time by slight and gentle uplifts and subsidences of broad areas.

These are examples of a great geologic principle. All regions of the globe have had similar periods of disturbance alternating with those of quiet, but as to time and intensity they have differed among themselves. In the earlier days of geology these crumpling disturbances were usually ascribed to the cooling and consequent shrinkage of the globe. Other hypotheses are now in the field, and the contest is still in full swing. Whatever their cause, we do not find much evidence of a general decrease in the activity of such internal earth forces. On the contrary, the middle Tertiary revolution was one of the most widespread and intense of which we have any record. There have been many fluctuations but no general trend.

Volcanic action likewise varies in intensity, and transfers its activity from one region to another from period to period; generally accompanying but locally ignoring the diastrophic disturbances. Yet, on the whole, the volcanic activity of the last two geologic periods is equal in intensity and widespread distribution to anything known to us in earlier periods.

The demolishing of the hills and mountains by streams, winds, glaciers, and the other erosive agencies proceeds most actively during the periods of crumpling. At such times broad, flat-bottomed valleys are planed off only on the outcropts of the *softest* rocks. The wearing away of the harder masses proceeds at a much slower pace. Before such plains can be extended over the more resistent outcrops, the heaving and sagging of the uneasy earth interrupt the process and rejuvenate the erosion cycle.

Eventually the internal unrest subsides; the body movements virtually cease for a long period until renewed in the oncoming of the next orogeny. In this period of relative quiet, the erosive agencies are able to reduce to comparative flatness not only the outcrops of the soft, but also the harder rocks, until peneplains of broad extent have been produced. Only the hardest masses and those farthest removed from the main drainage channels continue to stand out as mountains. The early Cambrian and the Jurassic periods saw peneplains extended over most parts of North America of which there is sufficient record. Meanwhile, the adjacent seas were gradually being filled with the detritus swept from the land, and were in consequence creeping out upon the continental platforms in the form of shallow seas.

To-day we evidently are living in the midst, or perhaps near the close, of one of the lesser periods of internal disturbance. For this reason our broad plains of erosion, such as the Mississippi Basin, Central Russia and northwest Siberia are limited for the most part to the outcrops of soft rocks. Nevertheless, we appear to have, even to-day, in central Canada and eastern Siberia ancient peneplains, on hard rocks, which have been so little dusturbed and dissected that they still retain in large measure their distinctive character.

For a hundred years or more paleontologists have been gathering and assembling information regarding the kinds of animals and plants represented by the fossils in the rocks. From them we learn the distribution of these plant and animal societies both in space and time. When enough information has been gathered regarding the distribution of the marine sediments and faunas of a particular age, we are in a position to map, at least roughly, the sea and land areas of the time. Such maps have been made within the last few years in considerable variety and for more than one of the continents. They are admittedly crude approx-

imations to the truth; yet they show certain general facts that are fairly well substantiated. The more detailed studies of this kind have made us realize that throughout the recorded part of geologic history there have been alternate expansions and contractions of the oceans, with reciprocal changes in the land areas. Schuchert has estimated that about the middle of the Ordovician time the sea covered two thirds or more of what we now call North America, as well as large parts of other continents. It was one of the distinctively oceanic epochs. On the other hand, the epochs that began and terminated the Paleozoic era were times of diastrophic activity marked by such extreme contractions of the ocean-covered areas that we can find on our present lands only small traces of the marine strata of those ages. The rest of them are doubtless buried beneath the present oceans.

These oscillations of the shore-line seem to be wholly irregular and pulsating. We can discern no definite tendency toward either a progressive contraction or a progressive expansion of the ocean. If there be such a tendency, it must be so gradual that even many geologic periods are not sufficient to reveal its nature to us. Only on theoretical grounds may we suspect that the oceans are constantly growing a little larger, for they are receiving from time to time water derived from the steam of volcanic eruptions; and there is reason to think that much of this water is a real contribution from the interior of the earth and that it has never before been a part of the hydrosphere.

We have come to understand that the hills, mountains, valleys and other topographic details of the land are almost entirely the result of what James Geikie has aptly called "land sculpture." Streams of water, the wind, glaciers, the waves of the sea and still other agencies combine their efforts to produce a composite result, which in some regions may be more the work of one agency and in others largely the work of another.

On the average these various processes of erosion seem to work with exceeding slowness. The pyramids of Egypt, now nearly six thousand years old, have suffered only trivial wear from the continual sandblast action of the desert winds through all those centuries. From estimates of the amount of material carried out by the streams to the ocean in solution and in suspension each year, we may calculate that the continents are being worn away at a rate which, if evenly distributed, would be sufficient to lower the land surface one foot in about every 10,000 years; but we are well aware that this erosion is much more rapid in a few specially favored localities than elsewhere and hence that over most of the land the rate of denudation is correspondingly slower.

On the other hand, we have clear evidence that these processes have brought down nearly to base-level large areas of land surface in a mere fraction of one of our geologic periods. The Paleozoic rocks of southern Oklahoma, compressed, folded and strongly elevated late in the Pennsylvanian or Carboniferous period, were beveled off to such an extent before the Permian period that the rocks of that age now rest upon the truncated edges of the older beds, although but a fraction of the Pennsylvanian period intervenes between the two events. In the Rocky Mountains of Colorado and Wyoming an interval of active erosion, following the first uplift of the Rocky Mountain system, stripped off the many thousands of feet of sedimentary formations to such an extent that the old pre-Cambrian crystalline terranes were exposed to erosion before the oldest Tertiary strata were deposited. This lapse of time, although amounting, no doubt, to hundreds of thousands of years, was so short that it now appears to us only the quick transition between two of our commonly recognized geologic periods. Few things show more clearly how coarse are the divisions on the great time-scale of earth history.

Our knowledge of the climates of even the better known periods of geologic history has lagged behind that of the physiographic and biologic changes. For a long time inferences were drawn almost entirely from the nature of the fossils. Coral reefs were understood to mean tropical or sub-tropical climates. The bones of reindeer in France and of musk-oxen in Kentucky indicated a colder climate than that enjoyed by the same regions to-day. On the other hand, the leaves of palms and bread-fruit trees, preserved in lignite beds on the coast of Greenland, suggested a much milder

climate there, in one of the early Tertiary epochs. Unfortunately, many formations contain no fossils or only such as have no clear significance.

More recently the nature of the sedimentary rocks themselves has been recognized to be indicative of climate. It was pointed out long ago that ancient glacial beds in India showed a period of cold climate in a region which is now warm. Beds of rock salt in the Permian strata of Germany were correctly interpreted to mean arid conditions. But it is only recently that the climatic relations of the less extreme, through much more common, types of sediments have come to be understood in a general way. In the not distant future we may expect to read the climatic significance not only of all terrestial deposits but to some extent even of the marine formations, although the latter are much less affected by changes of climate.

An individual rock formation is itself a more or less legible record of the local climatic conditions at the time and place of its origin. Such local climates must have been related in considerable measure to temporary features of the land topography. Thus, some of the deposits which indicate aridity were probably laid down on the lee sides of high mountain ranges. Others were due to the prevailing distribution of oceans and currents. It has long been recognized that the broad expansion of seas in the Ordovician and Silurian periods must have favored an untrammelled circulation of currents capable of equalizing temperatures between the tropical and polar regions far more effectively than is possible to-day.

In spite of such local influences on climate, we may, by considering the climatic implications of all the formations of a particular epoch, gain a general impression of the average climate of the globe for that time, and these average climates may be compared among themselves and with that of the present. Although only a good beginning of this work has been made thus far, it should be but a few years till we shall understand ancient climates at least as well as we already know ancient land configuration.

All that we have learned thus far about the earth's climatic history goes to show that, ever since the earliest periods of which we have a sufficient record, there have been frequent oscillations between colder and warmer and between moister and drier climates, but always within narrow limits. At no time does the climate appear to have been inimical to life over all or even half of the globe. To-day over a considerable part of the land surface it is so dry, as in central Arabia, that scarcely any plants or animals can exist. On the Antarctic continent—once inhabited by a varied assemblage of plants and doubtless animals—life has been practically exterminated by the outward growth of the great ice-sheet. We have no evidence in geologic history that conditions have ever been especially more severe; and yet in the records of almost every geologic period back to the Archean we find some places which have been glacial and others which have been arid.

Temperatures between 0° and 80° Centigrade, at least during the growing season, are required by nearly all living creatures, and for the vast majority of them the range is less than 40°. The polar districts are to-day below the minimum, and much larger areas have been as cold in certain past epochs; but we have no evidence that the maximum has ever been exceeded. This is a very narrow range, and yet the fluctuations of terrestrial climates seem to have been confined within it ever since the Archean period, if not earlier. The writers of the older text-books of geology, placing perhaps too much confidence in the nebular hypothesis of Buffon and La Place, supposed that the temperature of the earth had constantly decreased from the white heat of an astral period down through an era of molten rock, and a later one of vaporous oceans, to conditions as we find them to-day. The accumulating testimony of the sedimentary strata does not appear to support this supposition. This record, extending back perhaps some hundreds of millions of years, seems to reveal to us a history marked by slight oscillations of climate, but in a broad way singularly uniform and without evidence of a progressive increase or decrease of either general humidity or temperature.

In view of opinions which were generally current a generation ago that geologic history

revealed a slow but stately progression from smaller to larger continents, from more active mountain-building and volcanic action to quieter conditions, and of warmer, moister climates to colder and drier climates, these results of more recent studies are particularly instructive. The earth's physical history, during the past fifteen or more geologic periods, seems actually to be represented by neither a perceptibly ascending nor a descending curve, but by a slightly wavy line which is either essentially horizontal or more probably is rising or descending so very slowly that all of the recognized periods of the earth's history combined are too short to show the trend.

When we turn to the history of living things on the earth, however, we have unrolled before us a definite progression which we are accustomed to regard as an upward trend.

Logically, geologists should not include the history of organisms as a part of their science. Such matters should concern the zoologist and botanist. From the outset, however, geologists have been much interested in the study of fossils and the biologists have seldom protested against this adoption. The study of fossil organisms has indeed absorbed nearly all the attention of many men generally regarded as geologists.

No question related to the earth's history arouses greater interest than that of the origin of life. Yet of the beginnings of life we have absolutely no trace in the geologic record. Our notions regarding that remarkable event are necessarily derived from speculations based on the known laws of chemistry and physics, and on the theories of evolution.

Land plants of such familiar types as the ferns and club-mosses we have traced by their fossil remains back to the Devonian or even to the Silurian period. Ages before that, at least as far back as the early part of the Algonkian period, the sedimentary deposits were of such a nature as to strongly indicate that the land was in part covered by an effective mantle of vegetation. This may have been supplied by the mosses and lichens, such as now form that thick and characteristic blanket of the ground in the sub-arctic regions—the "tundra." They would effectively cover the ground, but only under the most favorable circumstances could they be preserved as fossils. Aquatic algæ have been satisfactorily identified in considerable variety in rocks that were laid down early in the Proterozoic era; and there are indirect evidences and perhaps the actual fossil remains of bacteria quite as early. On purely theoretical grounds this has long been expected.

Animals of comparatively advanced classes, such as the arthropods, were highly diversified as far back as the lower Cambrian epoch and have been reported from even older rocks. Simpler animals, such as the radiolarians, have been detected in the pre-Cambrian rocks of France. We may, therefore, reasonably expect to find fossil animals in even the oldest sedimentary rocks, if they are not so altered by metamorphism as to have lost their original structures.

Under the best of circumstances, however, we can hardly hope to find traces of animals more primitive than those represented among groups already known in fossil and living form.

No branch of geologic history has been so assiduously studied as the evolution of the animals. Thanks to this activity, ranging over more than a century, we now have a large fund of information from which to generalize. It has long been recognized that new genera, orders and classes have made their appearance one after another, risen to prominence, flourished for a while, and then declined either to extinction or to a lowly status where some of them have lingered on in obscurity through many succeeding periods. The ammonites, which once inhabited every sea on the globe in great variety, disappeared utterly at the close of the Mesozoic era, and to-day we have nothing more closely related to them than their cousin, the Nautilus. The great class of reptiles, which dominated the land in the Mesozoic era, and whose sway was then apparently unchallenged by any other living thing, has largely disappeared and such types as have survived to the present day have been relegated to the jungles and waste places of the earth, where they must depend for the most part on concealment or upon fleetness to escape from their more powerful enemies.

Many explanations of these declines and extinctions have been offered—a few absurd, others plausible. Doubtless several causes were involved in the result. But whatever the cause may have been, it is evidently a law of nature that the career of each type and of each group must take the form of a rising and falling curve.

We now clearly understand that in the course of this rise and fall of species, genera, and larger groups, there has been a slow but steady increase in complexity of structure and in function, in both animal and plant bodies. The worm has been succeeded by the more highly constituted mollusk, which has in turn been supplanted by the arthropod, the fish, and finally the mammal.

Each animal type seems to embody an experiment to test the worth of one or more important new devices which are the distinctive contribution of that type to the progress of animal development.

The trilobites in the sea and the insects on land introduced the wholly coordinated nervous system and the power of rapid well-directed motion, with better seeing powers and even the possibility of flight in the air. These improvements represented a great advance over the corals, which wait helplessly for their food to drift into their mouths, or even over such worms, starfishes and mollusks as slowly grope through mud or sand or crawl with proverbial snail's pace over the surface. In a broad sense, the arthropods may be said to have introduced into the world the rapacious habit—the active pursuit of food.

Another advance was represented by the first vertebrates and particularly by the fishes, which have attained nearest to perfection of all water-inhabiting animals either previous or subsequent. They invented the spindle form and the stern propeller, both of which have been imitated necessarily by every successful swimming thing from the shark, the ichthyosaur and the porpoise to the modern submarine torpedo. The fishes also introduced the photographic or image-recording eye, which is far superior to the light-sensitive spots of certain echinoderms or even the remarkable compound eyes of the insects.

The reptiles in their turn devised the solid bony skeleton without which active life upon the dry land had previously been limited to small animals such as the insects. They introduced the encased egg, capable of being incubated in air instead of water. This placed the class one step ahead of the amphibians, which must always remain near water. The reptiles invented also a type of cover which was able to withstand the evaporation of the body liquids, without loss of that flexibility which was essential for rapid motion. They were not, however, so successful in coping with that other element of climate—temperature. The chill of winter reduced their bodily processes to inaction and obliged them to hibernate except in the warmer months in the year. For that reason they must always have been, as they are now, largely confined to the warmer parts of the globe.

The probable descendants of the reptiles—the mammals—somehow contrived that wonderful invention, warm blood, and with it the necessary heat-conserving cover of hair. These enabled the mammals to range over nearly all parts of the globe regardless of climatic and seasonal changes and to maintain their bodily activities constantly at the most favorable temperature by oxidizing carbohydrates as bodily fuel. It would be hard to overestimate the importance of this innovation.

(To be concluded)

ELIOT BLACKWELDER
HARVARD UNIVERSITY

ON THE DIFFERENTIAL EFFECTS OF THE INFLUENZA EPIDEMIC AMONG NATIVE PEOPLES OF THE PACIFIC ISLANDS

SINCE the influenza pandemic of 1917-1918, the writer has had occasion to make two journeys to insular areas of the Pacific Ocean, for the prosecution of special field-studies. In two specific instances, incidental observations were made on the differential effects of the imported disease upon the human inhabitants of certain islands; it is the object of the present brief communication to record the essential facts.

I. The first area is that of the Society

Islands, of which Tahiti is the largest and best-known member. The fundamental point is that the pure-blooded natives of this group of islands suffered a mortality which was reported to vary from fifteen to twenty-five per cent. in different circumscribed communities, while the half-caste population lost a distinctly smaller percentage; the white inhabitants lost very few of their numbers, thus manifesting a high natural resistance.

The disease was brought to Tahiti in November 1918 by a vessel from San Francisco, some of whose passengers had developed the malady after embarking. The vessel was released from quarantine, despite the protests of the medical officials, and within twenty-four hours the contagion had begun its rapid spread throughout Papeete, the main town of Tahiti. So far as the writer could ascertain by enquiries in the summer of 1919, the incidence of the epidemic was about the same for all of the three classes of the community, distinguished above. Very few failed to contract the disease. Many natives fled from Papeete to the remote districts of Tahiti and to the other islands, so that all parts of the group were affected.

It was impossible to secure exact quantitative data as to the numbers of deaths among the three divisions of the population, for the figures have not been compiled by the authorities; but the qualitative result stated above became clearer with each additional conversation with medical men and traders, and with numerous native chiefs and commoners. In every case, the questions were framed so as to elicit a statement without disclosing the point at issue; those who are familiar with native peoples will realize that this is a necessary precaution when seeking information. Without a single exception the statements agreed as to the essential facts.

Thus the natural resistance of the foreigners proved to be high, even under the adverse climatic conditions of the tropics, while the alien parentage of the half-castes gave to them a greater chance of survival as compared with the unmixed natives, among whose kind a prior process of selection had not occurred as among the nations of Europe and America.

2. The second instance is that of two different native peoples that exhibited an astounding difference in mortality when attacked by the same disease. In the summer of 1920 the writer visited the Mariana or Ladrone Islands, where most of the available time was devoted to field-work in Guam; an opportunity was seized, however, to spend a few days on the island of Saipan, which lies about 120 miles to the northward of Guam. The principal settlement of this island is the town of Garapan, where the population comprises about 1,500 Chamorros, or Mariana Islanders, and an approximately equal number of natives of the Caroline Islands. The two peoples occupy distinct divisions of Garapan on either side of a dividing road, and they remain essentially separate in culture, dress, language and matrimonial relations.

At this place the writer found a gifted Spanish Chamorro named Señor Gregorio Sablan, who was the teacher-missionary as well as the official interpreter. He described the coming of the influenza epidemic by means of a vessel from Japan about a year before, and he gave very definite accounts of its ravages. As everywhere else, practically all of the inhabitants contracted the disease. The percentage of deaths among the Chamorros of Saipan was in excess of twelve per cent., while among the Caroline Islanders, equal in total number, the deaths were stated to have been *only six, or about four-tenths of one per cent.*

Clearly, then, the latter people displayed a degree of resistance to the pandemic that is astonishingly high in comparison with that of all of the other islanders which the writer personally observed. The circumstances in Garapan are such as to bring out this fact most sharply, because the two contrasted groups of natives lived in the same community under practically identical conditions of housing and regimen. Only in the matter of dress was there an obvious difference. The Chamorros clothe the body completely, after the manner of the Filipinos, while among the Carolinians the men are naked save for a small loin cloth, and the women wear a fiber mat, or length of cloth, around the body from the waist to the

knees. It is at least conceivable that the differences in such respects might affect the temperature reactions of the body during fever, more advantageously in the case of those with less clothing. But if this is the explanation in the particular instance under consideration, it does not seem to hold in others; the Melanesians to whom the disease was brought suffered as greatly as the Chamorros and Tahitians, according to reports, although they cover the body at least as little as do the Caroline Islanders. Whatever the explanation of the Saipan observations, the fact remains that the two contrasted peoples differed greatly in their mortality; in the absence of any distinguishable external factors, their difference is most reasonably to be attributed to constitutional peculiarities.

Henry E. Crampton

Barnard College,
Columbia University,
December 24, 1921.

PRESENTATION TO PROFESSOR EMERSON

This society has come at last to the fountainhead of American geology—Amherst College. Nearly a century ago, while Amos Eaton was inspiring students at the Rensselaer School by his novel modes of teaching, and Silliman the greater, at Yale, was illuminating the facts and fancies of this science by his brilliant and fascinating deliveries, Edward Hitchcock was actually creating a geological survey of this Commonwealth of Massachusetts and initiating classes of students into the astonishing revelations and practical applications of a new science. It was a difficult field he found here in this Connecticut Valley and its complicated uplands; many different categories of geological facts crowded upon him, but he interpreted them with clarity and with such degree of distinction that he was, in due course, selected by Governor Marcy of New York as the first state geologist for that well organized survey; an appointment which he accepted, entered upon but soon abandoned because that field was too far away from Amherst College—indeed, reason in plenty!

Let us remind ourselves that Edward Hitchcock was a distinguished divine, professor of natural theology and geology and president of this college, in the most uplifting days of the last century. This minister of the gospel was boldly entering upon paths lined with harvest fields of truth which to his contemporaries were fields of poison weeds. With equanimity he faced the bigotry of common ignorance and the theological odium; but his students heard and followed him gladly into those days of delightful and romantic adventure over this countryside, when every hill and knoll, each stream and gully, each glacial boulder and picturesque retreat was baptized by the geologist-president and his classes, with ceremonies of address and poem and song: Mounts Castor and Pollux, Mount Pleasant and Mount Pleasanter, Mettawampe and Aquilo, the Crescent, the Occident, the glacial stones Rock Rimmon, Rock Oreb, Rock Etam, and so on through a long list of natural monuments; names which should never be permitted to disappear from the map of Massachusetts, for they are storied monuments not only of her science and her scenery but of one of her great sons.

If I pay thus brief tribute to the eminent Hitchcock, it is only to intimate the influence which helped to mould this other great teacher of our science to whom we are come tonight with our hearts in our hands. Professor Emerson has grasped the very horns of the altar of this science, and as we consider wherein has lain his glowing success as a teacher, let us remember the atmosphere he breathed here in his student days. It was an atmosphere sweetened by the fragrance of a science just bursting into flower, tinged with joyous and natural emotions, but never robbed of its spirit of devotion. Teachers are the personifications of immortality. The men whom Emerson trained, and who have arisen one by one to their own niches in the science, sent out in

[1] Address of presentation to Professor Benjamin Kendall Emerson, LL.D., of Amherst College, at the annual meeting of the Geological Society of America, at Amherst, December 29, 1921.

their turn the influence that here inflated their hopes; and their own students, now turned teachers too, have sent the echos of the Emersonian days flying—an endless course, like the pursuit of the truth. The footprints in the Connecticut River sandstones were to Longfellow the theme of the Psalm of Life; to Hitchcock they were more than footprints on the sands of time; he saw in the varying depth of these impressions, made heavier on one side than on another as the creature changed its course or turned a corner, the play of a different muscle and the nerve message from the brain which compelled the muscular motion. There he found, registered in the immortal rocks the very purpose and impulse of life. And thus too, the great teacher. While about these tables, there are some who owe Professor Emerson a direct allegiance, probably there are none who have not been reached by the ever widening rings of his influence or been guided by his imprints on the science. We are here tonight to heap upon him our pledges and congratulations, to establish thus a milepost to mark here the passage of the years. Every rock in the fields of Old Hampshire County claps its hands and the mountains of the Commonwealth break forth into singing, for they are his by a peculiar right and by an emphasis of interest. To him who has sounded their depths and touched their heights, whose eyes have looked in upon the record written in their hearts, whose inspired hammer has loosened their tongues that their tales may be a part of human knowledge and their secrets turned to the advantage of the state —it is to him we make our pledge of admiration and regard. When Edward Hitchcock retired from the presidency of Amherst College, the trustees not knowing, perhaps, how else to express their substantial regard, presented him with silver plate. So too we, in best of heart and with keener sense of our act, ask you to believe this gift which comes from all of us, is but the miniature symbol of the measure of our regard.

JOHN M. CLARKE

SCIENTIFIC EVENTS

DR. WHITE'S GIFT TO MORGANTOWN AND THE UNIVERSITY OF WEST VIRGINIA

DR. I. C. WHITE, since 1897 state geologist of West Virginia, distinguished for his contributions to the geology of coal and petroleum, and Mrs. White have given to the University of West Virginia and the city of Morgantown 1,911 acres of Sewickley coal, situated on Helen's Run, in Marion County. Officers of the geological survey estimate that the tonnage of the acreage will approximate 15,000,000 and on a conservative royalty basis should yield at least $4,000,000 over a period of years, $2,000,000 to the city and $2,000,000 to the university.

Dr. F. B. Trotter, president of the university, and City Manager Sutherland have issued the following statement:

The funds arising from the sale or lease belonging to the West Virginia University are to be used as follows:

The income from the proceeds of said coal is to be used in assisting the State of West Virginia to equip and maintain a geological department of the State University at Morgantown, West Virginia, after the state shall have constructed an adequate fire-proof building, including museum space for minerals, fossils, working laboratories, lecture rooms, etc., the only restriction upon the expenditure of the income being that it shall be devoted solely to the use and benefit of the geological department of the State University in the city of Morgantown, W. Va.

The income from the moiety belonging to the city of Morgantown is to be used in equal proportions under the following two heads, viz.:

First: For assisting the city of Morgantown in the purchase, improvement and maintenance of a public park in or near said city, for the pleasure and enjoyment of all its people.

Second: For assisting the city of Morgantown in securing, equipping and maintaining a public hospital of ample size and facilities in which the citizens of Morgantown, West Virginia, and especially all those of limited financial resources, can secure proper medical and surgical attention at a minimum cost, and in case of the very poor, free of all cost for such medical, surgical and hospital care as is necessary for their restoration to health.

Dr. White's letter to the officers of the university reads:

It gives Mrs. White and myself much pleasure to be able to transfer to the state university as a Christmas gift, an undivided one-half interest in 1,911 acres of Sewickley coal located near Fairmont, Marion County, W. Va., for the benefit of the geological department of the university. Whatever of success has come to me in science and business has been due in large degree to the training I received at the university, my alma mater, and it gives me much happiness to be one of the first of her sons to recognize this obligation in a substantial manner.

The tract conveyed is, with the exception of a ten-acre tract, all in one solid block, and the Helen's Run branch of the Western Maryland Railway passes directly across the southwestern end of the same at a point from which the coal under the entire tract can be removed, with natural drainage to a shaft sunk along that railway. This Sewickley coal will have an average thickness of six feet, and hence with a liberal allowance for mining waste, the entire tract should yield, in round numbers, about 15,000,000 net tons of coal, or 7,500,000 for the university's portion. With the rapid exhaustion of the coal from the Fairmont region, it is reasonable to expect that within a period of a very few years a lease at not less than 25 cents per ton royalty can readily be obtained on this property, with agreements for increase as the years go by, so that on a graded royalty this tract should finally yield a net return to the university of approximately $2,000,000. It is doubly pleasing to make this gift to the university during the presidency of Dr. Trotter, under whose able administration such wonderful growth and advancement have been attained.

Trusting that this donation to the university is only the forerunner of others to come from its prosperous graduates, and with best wishes, I remain,

EXPEDITIONS OF THE FIELD MUSEUM OF NATURAL HISTORY

SOUTH AMERICA will be the field of four out of six scientific research expeditions to be sent out by the Field Museum of Natural History during the next five years. Two of these expeditions will gather geological specimens in the area from Brazil to Patagonia and two, one zoological and one botanical, will study the animal and plant life of Peru.

An archæological expedition will visit the Isthmus of Panama and the State of Columbia, South America, and at the same time an ethnology expedition will go to the Malay Peninsula. All expeditions will be gone by summer and will remain in the field for periods from two to five years.

The department of geology plans to extend its expedition over a period of five years. The first of these will be headed by Dr. Oliver C. Farrington, curator of the department, and will proceed to the gem producing localities of Brazil. One of the objects of this expedition is to secure a full series of minerals associated with the diamond. Two later expeditions under Dr. Farrington's direction will visit the important gold and iron mining districts of Brazil and the silver and copper producing districts of Peru and Bolivia. The latter expedition will also take specimens from the important nitrate and vanadium deposits of Chile.

Specimens of pre-historic vertebrate life will be searched for by the second of the geological expeditions which will visit the Santa Cruz beds of Patagonia, certain areas of the Pampean formation of northern Argentine and some of the cave deposits of Brazil. It is hoped to secure specimens of the great ground sloths, the Pampas horse and other types of vertebrate life of South America. The expedition will be under the direction of Mr. E. S. Riggs, of the department of historical geology.

The zoological and botanical expeditions will work together in the interior of the Sierras of Central Peru and in the region of the sources of the Amazon. The work will take these expeditions from sea level to the highest altitudes where life is found. At times they will penetrate into virtually tropical islands, large areas of land entirely surrounded by snow capped peaks which have developed species of animal and plant life that are found in no other place. Dr. Wilfred Osgood, curator of zoology of the museum will head the expedition which expects to bring back many new specimens of animal life. The botanical expedition will be under the direction of Mr. J. Francis MacBride, assistant botanist of the museum. The region the expedition will cover is almost

unknown as far as its plant life is concerned and valuable data will be secured by the expedition.

The archeological expedition under the direction of Dr. J. A. Mason, will endeavor to solve some of the interrelations of the ancient civilizations of the Americas. It will also attempt to establish proof of a connecting link between the ancient Maya and the Inca of Peru. The exploration of Colombia is expected to yield many interesting stone statuettes, clay images and gold ornaments of the ancient civilization that inhabited that country. The Department of Archeology also plans to penetrate the Colorado desert next summer and to work among the Eastern Apache and Navaho Indians.

The expedition headed by Dr. Fay-Cooper Cole will leave in June for the Malay Peninsula to study the origin and migration of the Malay and Negrite races. He will attempt to penetrate into the interior of Borneo by following up one of the rivers that empty into the Java Sea. The expedition will be in the field for an estimated period of two years and for the most part will be in contact with pygmies and the least advanced types of primitive Malays.

Dr. B. Laufer, curator of the department of anthropology, is planning a trip to China to study the aboriginal tribes of the island of Hai-nan. He will also make an archeological survey of the Province of Fu-kien and Manchuria in order to enlarge the Chinese collections of the museum.

THE AMERICAN ENGINEERING COUNCIL

THE American Engineering Council of the Federated American Engineering Societies held its first annual meeting at the Cosmos Club, Washington, on January 5 and 6, Dean Mortimer E. Cooley of the University of Michigan, president of the council, presiding. Officers were chosen, the work of the past year reviewed and discussed, action taken on important matters of public and technical service, new financial arrangements put into effect, committees named, new policies sanctioned and old ones reshaped, and a definite program outlined for the next twelve months.

A leading event of the meeting was a dinner in honor of Mr. Herbert Hoover, who, addressing the members of the council and their guests at the University Club, praised the work of the committee on elimination of waste in industry as a great and lasting public service, pointed the way for new engineering effort in the public interest, and expressed renewed devotion to the ideals of the council. Resolutions of apprecition of the service of the new Secretary of Commerce were presented to Mr. Hoover.

On January 1, 1921, the membership of the society was composed of six national and fourteen state and local societies, a total of twenty. On December 31, 1921, there were eight national and twenty state and local societies, a gain of eight member societies representing 1,414 member engineers.

The balloting for officers resulted in the reelection as vice-presidents of Dexter S. Kimball, dean of the College of Engineering, Cornell University, and J. Parke Channing of New York. W. W. Varney of New York was again chosen treasurer. L. W. Wallace was re-elected executive secretary.

The executive board of the council for 1922 is made up as follows: H. E. Howe, Washington, American Institute of Chemical Engineers; Professor C. F. Scott of Yale, L. B. Stillwell and Calvert Townley of New York, J. H. Finney of Washington, William McClellan of Philadelphia, and L. F. Morehouse of New York, representing the American Institute of Electric Engineers; J. Parke Channing and A. S. Dwight of New York, Charles H. McDowall of Chicago and Philip N. Moore of St. Louis, the American Institute of Mining and Metallurgical Engineers; L. P. Alford of New York, E. S. Carman of Cleveland, Dean D. S. Kimball of Cornell, Professor A. M. Greene of Troy, Dean P. F. Walker of Kansas, W. S. Lee of New York, Dean M. E. Cooley of Michigan, American Society of Mechanical Engineers; Professor J. W. Roe of New York, Society of Industrial Engineers; Morris L. Cooke, Philadelphia, Taylor Society; W. E. Rolfe, Associated Engineering Societies of St. Louis; W. W. Varney, Baltimore Engineers' Club.

Regional directors chosen for 1922 are:

District No. 1, W. B. Powell, St. Louis; District No. 2, Gardner S. Williams, Ann Arbor, Mich.; District No. 4, W. J. Fisher, York, Pa.; District No. 5, Paul Wright, Birmingham, Ala.; District No. 6, Lloyd B. Smith, Topeka, Kansas; District No. 7, O. H. Koch, Dallas, Texas.

ASSOCIATESHIP IN THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

IN the By-Laws and Rules of Procedure of the American Association, Article II, Section 2, is the statement that "Associates, on payment of five dollars, may be admitted to the privileges of a meeting, except voting." The associateship was planned for those who desire to attend a meeting of the association and to contribute toward the expenses of the meeting but who do not wish to join the organization permanently. Since the adoption of the new constitution, with the new by-laws and rules of procedure, there have been but two meetings, the Chicago meeting of the year 1920-21 and the recent meeting held at Toronto. No associates were registered for the Chicago meeting, but 247 were registered at the last meeting. These were mostly residents of Toronto.

The permanent secretary wishes to call the attention of all members and friends of the association to this, the first entry of associates upon the roll of the association. According to the prescribed rule, associates have all the privileges of the meeting for which they are registered, except voting. These privileges are considered to include the right to present papers at that meeting, but associates do not receive the journal SCIENCE, which is sent to members. The funds secured by the payment of associateship fees will be used partly to defray a portion of the expenses of the meeting and partly for sending circulars and invitations to prospective members during the following year. Members will not fail to appreciate the fine spirit shown by associates in making this contribution to the funds available for current expenses. This first roll of associates was secured through the very admirable work of the local subcommittee on membership, Mr. H. V. F. Jones, *chairman*, and the thanks of the association are especially due to Mr. Jones and the other members. It is planned that future publications of the membership list will include lists of the associates registered for each meeting.

BURTON E. LIVINGSTON,
Permanent Secretary.

SCIENTIFIC NOTES AND NEWS

AT the Amherst meeting of the Geological Society of America, Professor Charles Schuchert, of Yale University, was elected president. As vice-presidents were elected: Dr. Henry S. Washington, Geophysical Laboratory of the Carnegie Institution of Washington; Dr. Robert T. Hill, Los Angeles, California; Dr. W. D. Matthew, of the American Museum of Natural History, New York City; Professor T. L. Walker, of the University of Toronto, and Dr. Edmund Otis Hovey, of the American Museum of Natural History.

THE American Society of Zoologists, meeting at Toronto, elected as president Professor Harris Hawthorne Wilder, of Smith College. Professor Bennet M. Allen, of the University of Kansas, was elected vice-president.

AT the New Haven meeting of the American Association of Anatomists, Professor Clarence M. Jackson, of the University of Minnesota, was elected president, and Professor Harold D. Senior, of New York University, was elected vice-president.

JOHN RIPLEY FREEMAN, of Providence, R. I., was elected president of the American Society of Civil Engineers at the first session of its sixty-ninth annual meeting held in New York on January 18. Honorary memberships were conferred upon Charles Prosper Eugene Schneider of Paris, Luigi Luiggi of Rome, Samuel Rea, president of the Pennsylvania Railroad, Howard Swasey and Howard A. Carson.

DR. HIDEYO NOGUCHI, member of the Rockefeller Institute for Medical Research, was elected to honorary membership in the Society of Dermatology and Venereology of Moscow at its thirtieth annual meeting on October 16.

CHARLES W. GOODALE, of Butte, Montana, was awarded the gold medal of the Mining and Metallurgical Society of America at its annual meeting on January 10, for conspicuous services in safety and welfare work.

THE Crompton Medal, given annually by the Institution of Automobile Engineers for the best paper read during the session, has been awarded to Mr. H. L. Heathcote for his paper on "Ball Bearings."

DR. AUGUST PACINI, of Washington, D. C., was awarded the prize of $1,000 for research work in roentgen-ray experimentation by the American Roentgen Ray Society at its recent meeting in Washington.

SIR GEORGE T. BEILBY, Sir John Cadman and Professor J. S. Haldane have been appointed to represent science on the advisory committee for coal and the coal industry set up under the British Mining Act of 1920.

DR. E. N. MILES THOMAS has resigned the keepership of the Department of Botany of the National Museum of Wales.

DR. S. K. LOY, chief chemist of the Standard Oil Company's refinery at Casper, Wyoming, has been appointed consulting chemist of the Bureau of Mines in connection with the oil shale work.

DR. EMILIUS CLARK DUDLEY has been given leave of absence from the Northwestern University Medical School to accept an invitation from Yale University to give a course in clinical surgical gynecology at the Hunan-Yale College of Medicine, Changsha, China. Dr. Dudley expects to return to Chicago about July 1.

E. F. BURCHARD has been granted a year's leave of absence by the U. S. Geological Survey to undertake private work in oil geology in South America.

PRESIDENT ARTHUR A. HAMERSCHLAG, of the Carnegie Institute of Technology, sailed for Europe on January 17 for three months vacation. During his absence Dr. Thomas S. Baker, the secretary of the institution, will be the acting president.

DR. A. S. HITCHCOCK, systematic agrostologist of the U. S. Department of Agriculture, has returned from a trip to the Orient where he went to study the grasses, especially the bamboos. He visited the Philippines, Japan, central and south China, including the island of Hainan, and Indo-China.

PROFESSOR W. H. HOBBS, head of the department of geology at the University of Michigan, who has been conducting in the Pacific area a study of mountain growth and of the formation of coral reefs and islands, has now reached Europe. As exchange professor with Professor H. A. Brouwer, he will begin his lectures at the University of Delft the first week in February. Dr. Brouwer sailed for America on January 18 and before going to Ann Arbor expects to give an address before the Washington Academy of Sciences.

AT the meeting of the Federal Board of Surveys and Maps, held on January 10, at Washington, D. C., the following officers were elected: *Chairman*: William Bowie, chief, Division of Geodesy, U. S. Coast and Geodetic Survey, and chairman of the American Geophysical Union; *Vice-chairman*: A. D. Kidder, Cadastral Engineer, U. S. General Land Office; *Secretary*: C. H. Birdseye, Chief Topographic Engineer, U. S. Geological Survey; *Members of the Executive Committee*: Colonel G. S. Norvell, Military Intelligence Office, U. S. Army, and Commander W. D. Puleston, Hydrographic Office, U. S. Navy.

AT a recent meeting of the executive committee of the American Astronomical Union, Dr. Ludwik Silberstein, of the Research Laboratory of the Eastman Kodak Company, was appointed chairman of a Committee on Relativity. Other members of this committee are Dr. Edward Kasner, Columbia University, Dr. A. A. Michelson, University of Chicago and Dr. D. C. Miller of the Case School of Applied Science. A meeting of the American Section of the International Astronomical Union will be called some time in the early spring before the delegates sail for Rome, where the National Conference opens on April 20. At this sectional meeting it is hoped to have a report

from each of the committees as a basis for instruction to the American delegates.

BEFORE the Philosophical Society of Washington on January 14, an address was given by the retiring president, R. L. Faris, on "Some problems of the sea."

DR. EDGAR F. SMITH, president of the American Chemical Society, addressed the Rochester section of the society, December 19, on "A Glance at Early Organic Chemistry."

RALPH H. MCKEE, professor of Chemical Engineering at Columbia University, spoke before the Franklin Institute, January 12, on "Gasoline from Oil Shale."

MR. JOSEPH BARCROFT, F. R. S., fellow of King's College, Cambridge, will deliver the sixth Harvey Society lecture at the New York Academy of Medicine on February 11, at 8:30. His subject will be "The raison d'être of the red corpuscle."

DR. CAMPBELL P. HOWARD, professor of medicine at the University of Iowa, gave a Mayo Foundation Lecture on December 30, his subject being "Personal Reminiscences of Sir William Osler."

THE *Journal* of the American Medical Association reports that Professor Gaffky, who for many years was the director of the Berlin Institute for Infectious Diseases, has been honored with a monument erected over his grave in Hanover, his native city, by his pupils and friends.

As has already been reported in SCIENCE, plans are under way in France for the celebration of Pasteur's centenary in 1923. The celebration will chiefly consist in an international exhibition of hygiene and bacteriology which will be held from May 1 to October 31, 1923, at Strasbourg where Pasteur began his epoch-making researches. A monument to Pasteur will be unveiled at the same time. The celebrations are in charge of the University and City of Strasbourg, the Pasteur Institute of Paris and the Pasteur family.

DR. WILLIAM FREAR, since 1887 agricultural chemist at the Pennsylvania Agricultural Experiment Station, died suddenly of heart trouble at his home in State College, Pa., at the age of sixty-two years.

DR. JOSEPH MACDONALD, JR., founder and managing editor of the *American Journal of Surgery*, died suddenly of apoplexy on January 7, at his home in East Orange, N. J., at the age of fifty-two years.

MANY libraries doubtless contain duplicates of astronomical periodicals and books that are needed in other institutions. For the purpose of facilitating their purchase, exchange or gift, the National Research Council contemplates the compilation of a list of all duplicates that can be spared. This list will be mimeographed and widely distributed. Those who have duplicates to dispose of are asked to send a list of them to the National Research Council, Division of Physical Sciences, 1701 Massachusetts Avenue, Washington, D. C. It is desirable, but not essential, that it be indicated which of these will be sold, which exchanged, and which donated. A copy of the complete list will be sent on request.

THERE has recently been issued "A list of seismologic stations of the world" as Vol. 2, No. 15, of the *Bulletin of the National Research Council* (U. S. A.). It was compiled under the auspices of the Section of Seismology of the American Geophysical Union with the cooperation and assistance of the Research Information Service of the National Research Council. This list is incomplete, owing to conditions prevailing generally after the world war. It is desired to correct and complete the information in the files of the Research Information Service in preparation for a revised edition of the publication. To that end, a further, revised questionnaire is being distributed with the printed list. Extra copies of the questionnaire are available and will be freely sent to all who have additional information to contribute. It is requested that every one who notes errors or omissions in the "List" as issued bring these to the attention of the Section of Seismology of the American Geophysi-

cal Union, addressing communications in care of the Research Information Service, National Research Council, 1701 Massachusetts Avenue, N. W., Washington, D. C., U. S. A. It is hoped, further, that complete as well as accurate information may be supplied concerning all stations not now fully described.

THE Genetics Division of the California Agricultural Experiment Station is investigating the genus *Crepis* for the purpose of finding favorable material for genetic research. As many as possible of the species in this genus will be grown and tested. Incidentally material will be accumulated for a monograph on the genus. About 35 species from foreign countries are now being grown at Berkeley, but none that are native to North America. The object of this appeal is to interest American collectors in the work so as to secure viable seeds of American species during the present year. Seeds may be sent to Division of Genetics, University of California, Berkeley, California.

DR. C. E. RUBY is making a collection of verse of all varieties, whose subject matter relates to the sciences, with the ultimate purpose of publishing an anthology of such poetry. Readers of SCIENCE are invited to send any verses of this character, which may be available to them, or to send suggestions as to possible sources of such verse to Dr. Ruby, 7 St. Paul Street, Cambridge, Mass. In sending such contributions, it is desirable that the author's name, and other needful details, including the permission to publish the poem (if it is possible for the contributor to include this permission) accompany each poem.

FIRE during the night of January 9 in the laboratories of the department of anatomy, Loyola University School of Medicine, 706 S. Lincoln Street, Chicago, destroyed the collection of reprints and files of journals of Professor R. M. Strong. He writes that he would be grateful to authors who have sent him reprints in the past for any replacements which it may be convenient for them to make. The research material, unpublished drawings and loan collections of the department were essentially untouched.

UNIVERSITY AND EDUCATIONAL NOTES

THE Corporation of Yale University has received an anonymous pledge of $100,000 for the establishment of the William H. Carmalt professorship fund in the School of Medicine. The president was authorized to designate annually a professor of the medical school as the William H. Carmalt professor.

DR. ALLEN FISKE VOSHELL, former resident orthopedist at the Johns Hopkins Hospital, has assumed charge of the department of orthopedic surgery at the University of Virginia Medical School and Hospital.

THE General Education Board has offered $250,000 toward the one million dollars of the Radcliffe Endowment Fund provided that the rest of the million is raised by July 1.

DR. JOHN HEISLER is now carrying on the work of anatomy in the School of Medicine of the University of Pennsylvania, a position formerly filled by Dr. Piersol. Dr. G. P. McHoueh has been appointed a full-time instructor in physiology.

DR. AUSTIN BAILEY, who has recently been employed as superintendent of the apparatus division of the Corning Glass Works, has resigned his position to accept an assistant professorship in the department of physics at the University of Kansas.

MR. HUBERT H. NEWELL, of the Research Laboratory of the Westinghouse Electric and Manufacturing Company, has resigned to accept a position at the Worcester Polytechnic Institute.

E. A. ALLCUT has been appointed associate professor in the department of thermo-dynamics at the University of Toronto.

PROFESSOR J. W. NICHOLSON has been elected to a war memorial fellowship in physics and mathematics at Balliol College, Oxford.

DISCUSSION AND CORRESPONDENCE

DISCOVERY OF GIGANTIC FOOTPRINTS IN THE COAL MEASURES OF KANSAS

ICHNOLOGY still holds an important place in

the literature of paleontology, and it is a pleasure for the writer to add a new item to the information already given by Mudge and Marsh, many years ago, concerning vertebrate footprints of the Coal Measures of Kansas.

The literature has been summarized and a description of a large slab of limestone from Osage County, Kansas, bearing footprints has been given by Moodie in his monographic work on the Coal Measures Amphibia of North America. No new information concerning vertebrate footprints in the Coal Measures of Kansas has been published since that work appeared in 1916. The new discovery is thus all the more interesting, and especially so since a huge type of Coal Measures vertebrate, otherwise unknown, is indicated by these tracks. Moodie has likewise described, in the above-mentioned work and elsewhere, skeletal remains of a large labyrinthodont (?) but of a size insufficient to have made the tracks described herewith.

The present discovery relates to a series of eight footprints discovered by the sons of Dr. George Coghill and turned over to the writer for excavation and description. They were discovered in a heavy sandstone, a formation extending generally over eastern Kansas, lying just above the Weston Shales, exposed in a high cliff near the Dightman bridge over the Wakarusa Creek, some five miles southeast of Lawrence, Kansas. The series of tracks extended for a distance of twenty-five feet in a direct line, but several tracks of the series are evidently missing as they average about two feet six inches apart, and wider spaces occur in two places.

The tracks vary slightly in size, due doubtless to the plasticity of the matrix when the imprints were made. They have an average of six inches in breadth, by from six to seven inches in length, and both the front and the hind feet appear to be represented, as two of the imprints distinctly show the presence of four toes, while three of them show five toes.

One impression seems to indicate that the hind foot was placed over the impression of the front foot. These footprints, if properly interpreted, indicate the largest Coal Measures vertebrate so far known. A more detailed account, with photographs, will appear in a later paper on the subject.

H. T. MARTIN

PALEONTOLOGICAL MUSEUM,
UNIVERSITY OF KANSAS

LIESEGANG RING FORMATION

RECENTLY, I advanced a theory to explain Liesegang's rings.[1] Unaccepted theories were not discussed.[2] Bradford[3] objects to my theory, and to the omission of literature.

That I am unaware of some work on banded precipitates is possibly correct. However, I disagree with the chemical analysis[4] on which his adsorption theory is built. I agree with him that bands of lead chromate can be obtained in gelatine, also with silver nitrate in the gelatine and bichromate in aqueous solution. Further, I think that banding is the normal formation of precipitates, and may occur in any solution. The function of the gel is to fix—relatively—one of the ions, and render banding visible. Ordinarily the reaction between the ions is so violent and the field of the reaction so stormy that bands are destroyed. In my theory, *relatively fixed* was used, except in one place, and the discussion shows that an absolutely fixed state was not intended. In fact an absolutely fixed state of one ion, or a relatively fixed state of both ions —as in superimposed gelatine layers of $AgNO_3$ and $K_2Cr_2O_7$—tends to prevent banding. Bradford states that the ionic attraction of silver and chromate is insufficient to explain banding in gelatine and not in agar. However, silver chromate bands form in agar quite readily, and revision of the theory is unnecessary to explain banding in this gel. I agree with him that bands of lead chromate can be obtained in gelatine with proper concentrations of lead acetate and potassium bichromate. Direct reversal of the solutions, however, without change of concentrations is not a reliable method.

Band formation is beautifully illustrated in the growth rings of trees. Rings in gels are formed similarly.

[1] SCIENCE, July 22, 1921.

[2] Bancroft, "Applied Colloid Chemistry," 1921, p. 259.

[3] SCIENCE, Nov. 11, 1921, p. 463.

[4] *Biochemical Journal*, 1916, X, p. 173.

To quote briefly without essential change from my previous paper:

In a gelatine solution containing bichromate, when silver nitrate is added, concentric rings are formed because the ion in the gelatine is relatively fixed. The silver ion wanders out and forms a ring by precipitation. A region on the chromate side of the ring is freed from the chromate ion, and a corresponding region on the silver side is freed from the silver ion. Growth stops until the silver again wanders out through the precipitate, and comes within range of the chromate ion when the process is repeated. The essentials of this interrupted growth theory are given in the previous article. Holmes' [5] theory closely resembles mine. Bradford's assumes unnecessary facts to explain the phenomenon. Later, I expect to give a more detailed account of this common phenomenon.

HUGH A. MCGUIGAN

UNIVERSITY OF ILLINOIS,
COLLEGE OF MEDICINE,
CHICAGO

SPECIAL ARTICLES

THE IDENTITY OF CERTAIN YELLOW PIGMENTS IN PLANTS AND ANIMALS

LITTLE attention seems to be paid, from the physiological standpoint, to the fact that the yellow pigments in certain animal organs have been shown to be chemically identical with the yellow pigments common in plants.

Some cases of the identity of lipochromes (yellow pigments of animals) with carotinoids (carotin, xanthophyll, lycopersicin, and fucoxanthin of plants) have been known for several years,[1] and the list has recently been greatly extended. The lipochromes of the following animal tissues are now known to be either chemically identical or isomeric with carotinoids—the ear lobes, beaks, shanks, body fat and blood serum of fowls, and the yolks of their eggs;[2] and the fat of the body, blood serum, corpus luteum and milk of the cow.[3] It seems probable that the same is true of the nerve cells of some animals and of the blood plasma and body fat of the human body.[4] These pigments are not synthesized by the animals, but are merely taken up from their food.

It is well known that carotin ($C_{40}H_{56}$) is a highly unsaturated hydrocarbon. It has been shown[5] that part of the unsaturated linkage of its molecule is of a type that can be easily satisfied by direct addition of oxygen. Xanthophyll is carotin dioxide ($C_{40}H_{56}O_2$). Lycopersicin has the same empirical formula as carotin. Fucoxanthin ($C_{40}H_{54}O_6$) contains more oxygen than the others. The first two of these pigments are widely distributed in plants. Not only do they always accompany chlorophyll, but they are also found in flowers, fruits, seeds, and subterranean organs, and also in fungi.[6]

The physiological significance of the carotinoids has, of course, not been wholly neglected. It is commonly pointed out[7] that the tendency of carotin to unite with oxygen may be significant in connection with photosynthesis, which is a reduction process. Steenbock[8] has suggested that the fat-soluble vitamine is identical with some of the carotinoids, while Palmer[9] has cited cases that seem to cast doubt on this view. Years ago Schunck[10] suggested the question as to whether xanthophyll, being present in connection with both chlorophyll and haemoglobin, may not be of physiological importance in both cases.

Emphasis is commonly laid on the chemical similarity between the chlorophyll molecule and the hæmoglobin molecule, though similarity of function between the chlorophyll of plants and the haemoglobin of animals does not seem to have been definitely shown. An examination of half a dozen recent and standard works deal-

1 Proc. Roy. Soc. London, 72: 165. 1903. Z. Physiol. Chem., 74: 214. 1911-12.

2 Jour. Biol. Chem., 23: 261-279. 1915.

3 Ibid., 17: 191-263. 1914.

4 Jour. Amer. Med. Assn., 74: 32-33. 1920.

5 Thatcher. The Chemistry of Plant Life. 1921.

6 7 Palladin's Plant Physiol. Livingston. p. 19.

8 Sci. N. S., 50: 352-353. 1919.

9 Sci. N. S., 50: 501-502, 1919, and Jour. Biol. Chem., 46: 559-577, 1921.

10 Proc. Roy. Soc., London, 72: 176. 1903.

5 Holmes. *Journal American Chemical Society*, 1918, XL, p. 1187.

ing with the chemical phases of plant and animal physiology indicates general interest in the similarities between chlorophyll and haemoglobin. It would seem that the identity of lipochromes and carotinoids is worthy of equal attention.

The investigation of what the carotinoids of plants and lipochromes of animals have in common physiologically would seem to be a hopeful line of work. The fact that they may readily take up oxygen seems to furnish a starting point for thought and work, which will be important, whether the results prove positive or negative.

Geo. B. Rigg

University of Washington

RATE AND MODE OF SOIL DEPOSITION IN THE PALOUSE AREA OF WASHINGTON AND IDAHO

During the last eight years the writer has had the opportunity to observe the formation of soils on the Columbia Plateau by the wind. The soils are often a hundred feet deep or more, and are virtually great dunes of silt brought sometimes for great distances. The area where these dunes lie is locally called the "Palouse," well known for its deep and very fertile soils.

Dust storms are frequent, and, curiously, the dust deposited is generally not raised near the place of deposition. It comes from an area of widely different characteristics. This accords strictly with Richtofen's theory of loess. The loess is formed when the wind moves particles of silt from an arid or semiarid area and deposits them in a more humid one. Once deposited upon the moister land, the silt particles are not raised again but become a permanent acquisition to the more humid area. Two factors cause the permanency of the deposit, first the moisture in the soil causes coherence in the deposited mass, and secondly the heavier vegetation forms an entangling mesh. Shaler noted the same conditions prevailing in the formation of loess on the upper course of the Missouri River in Montana.

In the Palouse great dust clouds flying high in the air often nearly obscure the sun at a time when the soils for many miles around are too damp to be blown. A rain or snow fall then clears the atmosphere, carrying the dust particles to earth, and they do not rise again. At the present time drifting seldom takes place but in the past it must have done so. Otherwise the dune shaped hills extending at right angles to the direction of the prevailing winds can not be explained. Thus the deep soils over the lava plains between the Columbia Valley and the Bitter Root Mountains have been formed at the expense of the drier eastern slope of the Cascade Mountains and the Columbia Valley.

To measure accurately the amount of soil brought into an area annually is well nigh impossible. Only under particular conditions is it possible to measure that brought in by a single storm. To do so it is necessary that the soils upon which the deposit takes place be not moved by the wind bringing in the dust. Once deposited, the material must not be lifted again by the same wind, and that brought to earth must be kept separate from older deposits.

A particularly favorable situation for making measurement was presented over the eastern part of the Palouse on January 29, 1917, and at that time a series of collections was begun at Moscow, Idaho, by the writer. From that date to March 23 four dust falls took place, upon all of which measurements were possible. On the afternoon of January 28 a fall of pure white snow took place. The following morning it was covered with a coat of chocolate brown dust of variable thickness. At the time practically the whole area was covered with snow. The dust therefore must have been carried nearly a hundred miles and probably was carried twice that distance.

Measurement of the amount of material deposited was made by collecting the dust covered snow from five different areas of average contour, each of four square feet in area. The snow was melted, the water evaporated and the dust weighed. From the result the deposit upon an acre was calculated as 140 pounds. Similar dust falls occurring on March 21, 22, 23 brought, respectively, 196 pounds, 184 pounds and 585 pounds per acre as measured in the same way. The total for the four dust falls is 1,105 pounds in 55 days or approximately

7,500 pounds per acre per year. This deduction of course assumes that the dust falls occur with equal frequency throughout the year. Recognizing that such an assumption is not warranted, we have made careful observation for the last three years to estimate whether the calculated amount might be below or above the actual. And though accurate measurements have been impossible we are convinced that at least the amount given is deposited in this way each year. The annual accumulation, however, does not differ widely from this figure. Many times repeated determinations of the weight of an acre foot of this soil show it to be very close to 2,450,000 pounds per acre. At the rate of accumulation just given it would require 326 years for the deposition of one foot, or approximately four inches is deposited in one century. This is four times as much as estimated by Free. If no erosion took place during deposition, according to this estimate, 25,000 years were necessary for the deposition of the seventy-five feet of soil that covers the lava beds on this plateau.

Considerable further work has been done by the writer along this line but does not bear directly upon the mode and rate of formation of this soil. The work is now to be discontinued unless some one else will take it up. A fine problem is presented in historical geology or physiography, and it is hoped that some person remaining in the vicinity of these interesting deposits will find time to take up a study of them. A measurement of the depth of the soil and more accurate measurements of the rate of deposition are problems that will lead to extremely interesting deductions regarding the age of the various lava outflows.

P. P. PETERSON

IDAHO FALLS, IDAHO

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORT OF THE TREASURER FOR 1921

IN conformity with Article 15 of the Constitution and by direction of the Council, the treasurer has the honor to submit the following report for the period December 23, 1920, to December 19, 1921, both inclusive.

The total of cash receipts during the year is $7,064.65. Disbursements made in accordance with directions of the Council amounted to $7,959.93. These include $2,172.36 for purchase of $2,500 of the United States Second Liberty Loan bonds for the association and held as an investment.

The total amount of funds of the association consisting of cash, cost value of securities purchased, and appraised value of securities received from the Colburn estate is $121,414.77.

A detailed statement is appended.

ROBERT S. WOODWARD,
Treasurer.

WASHINGTON, D. C.,
DECEMBER 19, 1921

BALANCE SHEET—DECEMBER 19, 1921

ASSETS

Investments:		
Securities (Exhibit "A")		$121,414.77
Cash in banks		5,585.90
		$127,000.67

LIABILITIES

Funds:		
Life and Sustaining Membership:		
438 at $ 50	$21,900	
16 at $100	1,600	
6 Sustaining	6,000	
		$ 29,500.00
Jane M. Smith Fund		5,000.00
W. Hudson Stephens Fund		4,381.21
Colburn Fund		77,755.74
Accumulated Investments		4,777.82
Unappropriated Interest		5,585.90
		$127,000.67

CASH STATEMENT

RECEIPTS

1920		
Dec. 23—Balance from last report		$ 6,481.18
Interest from securities	$5,834.24	
Interest from bank balance	30.41	
Revertment of grant made to Theo. Hough	100.00	
11 life commutations, 1921	1,100.00	
		7,064.65
		$ 13,545.83

DISBURSEMENTS

Investments:		
$2,500 U. S. Second Liberty Loan:		
Purchase price	$2,170.80	
Interest purchased	38.07	
Commission	1.56	
		$ 2,210.43
Grants:		
Gerald L. Wendt	$ 200.00	
Graham Edgar	200.00	
Sebastian Albrecht	200.00	
Caroline E. Furness	200.00	
Frank B. Taylor	300.00	

Seismological Society of America	200.00	
P. W. Whiting	200.00	
N. A. Cobb	450.00	
Geo. B. Rigg	300.00	
T. R. Garth	150.00	
E. G. Boring	150.00	
A. L. Kroeber	200.00	
Frank A. Hartman	150.00	
W. E. Garrey	200.00	
Carl J. Wiggers	150.00	
W. F. G. Swann	150.00	
H. M. Randall	250.00	
Walter G. Cady	200.00	
Paul F. Gaehr	100.00	
A. L. Foley	100.00	
Helen H. Roberts	150.00	
Solomon Lefschetz	150.00	
Frank P. Knowlton	150.00	
		4,500.00
Subscriptions to SCIENCE on account of life members: 343 members at $3		1,029.00
2 life memberships from Jane M. Smith Fund		200.00
Rental of safe deposit box		20.00
Foreign exchange		.50
		$ 7,959.93
Cash in banks:		
Fifth Avenue Bank, N. Y.	$4,345.57	
U. S. Trust Company, N. Y.	1,240.33	
		5,585.90
		$ 13,545.83

(Exhibit "A")

SCHEDULE OF SECURITIES

SECURITIES PURCHASED

Par Value		Purchase Value
$ 10,000	Chicago & Northwestern Railway Co. general mortgage 4 per cent. bonds, due 1987	$ 9,425.00
10,000	Atchison, Topeka & Santa Fe Railway Co. general mortgage 4 per cent. bonds, due 1995	9,287.50
10,000	Great Northern Railway Co. first and refunding mortgage 4.25 per cent. bonds, due 1961	10,050.00
10,000	Pennsylvania Railroad Co. consolidated mortgage 4.5 per cent. bonds, due 1960	10,487.50
10,000	Chicago, Burlington & Quincy Railroad Co. general mortgage 4 per cent. bonds, due 1958	9,350.00
10,000	Union Pacific Railroad Co. first lien and refunding mortgage 4 per cent. bonds, due 2008	9,012.50
10,000	Northern Pacific Railway Co. prior lien railway and land grant 4 per cent. bonds, due 1997	9,187.50
10,000	New York Central & Hudson River Railroad Co. 3.5 per cent. bonds, due 1997	8,237.50
100	U. S. First Liberty Loan bonds	91.25
10,500	U. S. Second Liberty Loan bonds	10,172.36
2,000	U. S. Third Liberty Loan bonds	2,000.00
2,000	U. S. Fourth Liberty Loan bonds	2,000.00
6,500	U. S. Victory Liberty Loan bonds	6,373.66
		$ 95,674.77

BONDS FROM COLBURN ESTATE

		Appraised Value	
20,000	Acker, Merrall & Condit Co. debenture 6 per cent. bonds	$13,600.00	
7,000	Buffalo City Gas Co. first mortgage 5 per cent. bonds	1,540.00	
8,000	Park & Tilford Co. sinking fund debenture 6 per cent. bonds	6,400.00	
42,000	Pittsburgh, Shawmut & Northern Railroad first mortgage 4 per cent. bonds, due Feb. 1, 1952	4,200.00	
			25,740.00
$178,100			$121,414.77

All of the above named securities except those from the Colburn Estate are registered in the name of the association.

I certify that I have audited the accounts of the Treasurer of the American Association for the Advancement of Science for the period December 23, 1920, to December 19, 1921; that the securities representing the investments of the association have been exhibited and verified; and that the income therefrom has been duly accounted for.

The financial statements accompanying the Treasurer's report are in accord with the books of the association and correctly summarize the accounts thereof.

HERBERT A. GILL,
Auditor.

Dated, December 19, 1921.

FINANCIAL REPORT OF THE PERMANENT SECRETARY FOR THE FISCAL YEAR 1921

(October 1, 1920, to September 30, 1921)

DR.

To balances from last account:		
Checking account	$ 4,344.04	
Savings account	4,227.34	
Petty cash	13.21	
		$ 8,584.59
To receipts from members:		
Annual dues previous to 1920	$ 5.00	
Annual dues 1920	1,563.01	
Annual dues 1921	48,190.44	
Annual dues 1922 (paid in advance)	348.00	
Admission fees	630.00	
Life and sustaining memberships	2,100.00	
		52,836.45
To other receipts:		
Sales of publications	$ 1,955.91	
Misc. receipts, including subscriptions for journals for life members from Treasurer, postage, exchange, overpayments, etc.	1,385.69	
Unexpended balance of funds secured by Local Committee of Chicago meeting	157.40	
Interest on bank account	127.75	
		3,626.75
		$65,047.79

CR.

By publications:		
Publishers SCIENCE		$31,353.15
By Division and Academy Expenses:		
Division	$ 1,140.00	
Academies	355.00	
		1,495.00
By Expenses Washington Office:		
Salary, Permanent Secretary.	$ 2,500.00	
Salary, Assistant Secretary	750.00	
Salary, Executive Assistant	2,490.00	
Usual clerical help	1,612.98	
Special clerical help on membership list	1,313.27	
Travel expenses	1,475.61	
Office supplies	217.66	
Stationery and printing	3,521.74	
Telephone and telegraph	124.29	
Postage	1,026.21	
Benjamin collection of portraits and autographs of association presidents	300.00	
Refunds on account of overpayments	154.98	
Life and sustaining membership fees	2,350.00	
Bad checks	16.15	
Exchange on checks	21.91	
Miscellaneous	1,274.49	
		19,149.29
By Expenses, Chicago Meeting:		
General program	$ 1,002.50	
Preliminary announcement	955.36	
Refund for expenses incurred by Section Secretaries	277.48	
Miscellaneous	82.53	
		2,317.87
By Expenses, Grants Committee		29.47
Special Grant appropriation		500.00
		$54,844.78
By new balances:		
American National Bank:		
Checking account	$ 5,840.11	
Savings account	4,355.09	
Petty cash	7.81	
		10,203.01
		$65,047.79

I certify that I have audited the accounts of the Permanent Secretary of the American Association for the Advancement of Science for the fiscal year 1921; that they were found correct, and that proper vouchers covering disbursements were exhibited.

HERBERT A. GILL,
Auditor.

Washington, D. C.,
November 26, 1921.

THE AMERICAN SOCIETY OF NATURALISTS

THE thirty-ninth annual meeting of the American Society of Naturalists was held in the Medical Building of the University of Toronto on December 29, 1921.

At the business meeting the treasurer's report was presented, audited, and approved.

The terms of the representatives of the society in the Division of Biology and Agriculture of the National Research Council were, by vote, extended six months, so as to end on June 30, which is the end of the fiscal year of the council. Dr. Sewall Wright was elected a representative of the society in the division, for a term of five years, to succeed Professor H. S. Jennings. The other representatives are Professor Leon J. Cole (four years), Professor Bradley M. Davis (three years), Professor Ross G. Harrison (two years), and Professor George H. Shull (one year).

A communication was received from a conference of officers of various biological societies, called by the National Research Council to consider the feasibility of a federation of biological societies, requesting that the American Society of Naturalists appoint its president